CLAIMS

I claim:

1. A method of estimating electrical parameters of an earth formation using a measuring device disposed to be deployed in a borehole, the measuring device disposed to collect formation data, the measuring device having a pre-established model associated therewith, the pre-established model governing the processing of the formation data to determine electrical parameters regarding the earth formation, the method comprising:

(a) providing a simplified model associated with the measuring device, the simplified model making at least one simplifying assumption about the pre-established model;

(b) receiving a set of collected formation data regarding the earth formation, the set of collected formation data collected by the measuring device;

(c) normalizing the set of collected formation data to derive a renormalized dataset, wherein the renormalized dataset is substantially consistent with each of the simplifying assumptions in (a); and

(d) applying the renormalized dataset to the simplified model to estimate at least one electrical parameter of the earth formation.

2. The method of claim 1, wherein at least one of the electrical parameters estimated in (d) is selected from the group consisting of conductivity and dielectric constant.

3. The method of claim 1, in which the measurement device comprises a mandrel, and wherein at least one of the simplifying assumptions in (a) includes a simplified assumption with respect to the effect of the mandrel on the pre-established model.

4. The method of claim 1, in which the measurement device comprises a transmitter antenna of finite size, and wherein at least one of the simplifying assumptions in (a) includes an assumption regarding the size of an antenna in the simplified model.

5. The method of claim 4, wherein the assumption regarding the size of an antenna in the simplified model is that said antenna is infinitesimal.

6. The method of claim 1, wherein the measuring device collects formation data via analysis of an electric signal transmitted by the measuring device.

7. The method of claim 6, wherein the set of collected formation data includes data representing at least one characteristic of the electric signal selected from the group consisting of attenuation and phase shift.

8. The method of claim 1, wherein the set of collected formation data includes data that may be represented as a complex number.

9. The method of claim 1, wherein the renormalized dataset includes data that represent point-dipole values.

10. The method of claim 1, wherein (c) includes transforming the set of collected formation data into the renormalized dataset according to at least one member of the group consisting of:

(1) at least one predetermined equation;
(2) a predefined multi-dimensional look-up table; and
(3) a predefined one-dimensional look-up table.

11. The method of claim 1, wherein (c) includes transforming the set of collected formation data into the renormalized dataset according to weighted sums, the weighted sums comprising:

$$g'_a = \sum_{i=1}^{N} c_{ia} f_{ia}(g_a)$$
$$g'_p = \sum_{i=1}^{N} c_{ip} f_{ip}(g_p)$$

where g_a and g_p represent collected formation data, g'_a and g'_p represent corresponding members of the renormalized dataset, $i = 1$ to N terms in the weighted sums, f_{ia} and f_{ip} are functions representing preselected transformations between mandrel and point-dipole data over prescribed trajectories in the g_a, g_p plane, and c_{ia} and c_{ip} are coefficients chosen to produce values for g'_a and g'_p that approximate point-dipole values over an anticipated range of g_a and g_p.

12. The method of claim 10, wherein the one-dimensional look-up table comprises:

a plurality of sets of table data, each set of table data matched to a corresponding one of a plurality of hypothetical earth formations, each set of table data further including a predicted measurement and a corresponding renormalized measurement that are each indicative of an electrical parameter of the corresponding hypothetical earth formation, wherein transformation from each predicted measurement to its corresponding renormalized measurement substantially reflects application of one of the simplifying assumptions to the predicted measurement.

13. The method of claim 12, wherein (c) in claim 1 further comprises deriving members of the renormalized dataset by interpolating members of the set of collected formation data between sets of table data in the one-dimensional look-up table.

14. The method of claim 12, wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single dielectric constant value and a series of corresponding resistivity values.

15. The method of claim 12, wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single resistivity value and a series of corresponding dielectric constant values.

16. The method of claim 12, wherein each of a predetermined subset of the plurality of hypothetical earth formations assumes a selected dielectric constant value and one of a plurality of different corresponding conductivity values.

17. The method of claim 12, wherein the plurality of hypothetical earth formations includes a substantial vacuum.

18. The method of claim 1, wherein the simplified model includes a calibration factor to adjust for anomalies in the measurement device.

19. The method of claim 1, wherein the simplified model includes a component for adjusting for effects on the formation data caused by the borehole.

20. A processor-readable medium on which processor-executable logic may be stored, the processor-executable logic disposed to generate instructions to a computer processor, the instructions disposed to cause the computer processor to follow a method of estimating electrical parameters of an earth formation using a measuring device disposed to be deployed in a borehole, the measuring device disposed to collect formation data, the measuring device having a pre-established model associated therewith, the pre-established model governing the processing of the formation data to determine electrical parameters regarding the earth formation, method comprising:

(a) providing a simplified model associated with the measuring device, the simplified model making at least one simplifying assumption about the pre-established model;

(b) receiving a set of collected formation data regarding the earth formation, the set of collected formation data collected by the measuring device;

(c) normalizing the set of collected formation data to derive a renormalized dataset, wherein the renormalized dataset is substantially consistent with each of the simplifying assumptions in (a); and

(d) applying the renormalized dataset to the simplified model to estimate at least one electrical parameter of the earth formation.

21. The processor-readable medium of claim 20, in which the measurement device comprises a mandrel, and wherein at least one of the simplifying assumptions in (a) includes a simplified assumption with respect to the effect of the mandrel on the pre-established model.

22. The processor-readable medium of claim 20, in which the measurement device comprises a transmitter antenna of finite size, and wherein at least one of the simplifying assumptions in (a) includes an assumption regarding the size of an antenna in the simplified model.

23. The processor-readable medium of claim 22, wherein the assumption regarding the size of an antenna in the simplified model is that said antenna is infinitesimal.

24. The processor-readable medium of claim 20, wherein the measuring device collects formation data via analysis of an electric signal transmitted by the measuring device.

25. The processor-readable medium of claim 20, wherein the renormalized dataset includes data that represent point-dipole values.

26. The method of claim 20, wherein (c) includes transforming the set of collected formation data into the renormalized dataset according to at least one member of the group consisting of:

(1) at least one predetermined equation;
(2) a predefined multi-dimensional look-up table; and
(3) a predefined one-dimensional look-up table.

27. The method of claim 20, wherein (c) includes transforming the set of collected formation data into the renormalized dataset according to weighted sums, the weighted sums comprising:

$$g'_a = \sum_{i=1}^{N} c_{ia} f_{ia}(g_a)$$
$$g'_p = \sum_{i=1}^{N} c_{ip} f_{ip}(g_p)$$

where g_a and g_p represent collected formation data, g'_a and g'_p represent corresponding members of the renormalized dataset, $i = 1$ to N terms in the weighted sums, f_{ia} and f_{ip} are functions representing preselected transformations between mandrel and point-dipole data over prescribed trajectories in the g_a, g_p plane, and c_{ia} and c_{ip} are coefficients chosen to produce values for g'_a and g'_p that approximate point-dipole values over an anticipated range of g_a and g_p.

28. The processor-readable medium of claim 26, wherein the one-dimensional look-up table comprises:

a plurality of sets of table data, each set of table data matched to a corresponding one of a plurality of hypothetical earth formations, each set of table data further including a predicted measurement and a corresponding renormalized measurement that are each indicative of an electrical parameter of the corresponding hypothetical earth formation, wherein transformation from each predicted measurement to its corresponding renormalized measurement substantially reflects application of one of the simplifying assumptions to the predicted measurement.

29. The processor-readable medium of claim 26, wherein (c) in claim 20 further comprises deriving members of the renormalized dataset by interpolating members of the set of collected formation data between sets of table data in the one-dimensional look-up table.

30. The processor-readable medium of claim 26 wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single dielectric constant value and a series of corresponding resistivity values.

31. The processor-readable medium of claim 26, wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single resistivity value and a series of corresponding dielectric constant values.

32. The processor-readable medium of claim 26, wherein each of a predetermined subset of the plurality of hypothetical earth formations assumes a selected dielectric constant value and one of a plurality of different corresponding conductivity values.

33. A method of estimating electrical parameters of an earth formation using a measuring device disposed to be deployed in a borehole, the measuring device disposed to collect formation data via analysis of an electrical signal transmitted by the measuring device, the measuring device having a pre-established model associated therewith, the pre-established model governing the processing of the formation data to determine electrical parameters regarding the earth formation, the method comprising:

(a) providing a simplified model associated with the measuring device, the simplified model making at least one simplifying assumption about the pre-established model;

(b) receiving a set of collected formation data regarding the earth formation, the set of collected formation data collected by the measuring device;

(c) normalizing the set of collected formation data to derive a renormalized dataset, wherein the renormalized dataset is substantially consistent with each of the simplifying assumptions in (a), said normalizing including transforming the set of collected formation data into the renormalized dataset according to a predefined one-dimensional look-up table comprising a plurality of sets of table data, each set of table data matched to a corresponding one of a plurality of hypothetical earth formations, each set of table data further including a predicted measurement and a corresponding renormalized measurement that are each indicative of an electrical parameter of the corresponding hypothetical earth formation, wherein transformation from each predicted measurement to its corresponding renormalized measurement substantially reflects application of one of the simplifying assumptions to the predicted measurement;

(d) applying the renormalized dataset to the simplified model to estimate at least one electrical parameter of the earth formation.

34. The method of claim 33, in which the measurement device comprises a mandrel, and wherein at least one of the simplifying assumptions in (a) includes a simplified assumption with respect to the effect of the mandrel on the pre-established model.

35. The method of claim 33, in which the measurement device comprises a transmitter antenna of finite size, and wherein at least one of the simplifying assumptions in (a) includes an assumption regarding the size of an antenna in the simplified model.

36. The method of claim 35, wherein the assumption regarding the size of an antenna in the simplified model is that said antenna is infinitesimal.

37. The method of claim 33, wherein the renormalized dataset includes data that represent point-dipole values.

38. The method of claim 33, wherein (c) further comprises deriving members of the renormalized dataset by interpolating members of the set of collected formation data between sets of table data in the one-dimensional look-up table.

39. The method of claim 33 wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single dielectric constant value and a series of corresponding resistivity values.

40. The method of claim 33, wherein the one-dimensional look up table was previously generated by deriving each of the plurality of sets of table data for a single resistivity value and a series of corresponding dielectric constant values.

41. The method of claim 33, wherein each of a predetermined subset of the plurality of hypothetical earth formations assumes a selected dielectric constant value and one of a plurality of different corresponding conductivity values.

42. A method of estimating electrical parameters of an earth formation using a measuring device disposed to be deployed in a borehole, the measuring device disposed to collect formation data, the measuring device having a pre-established model associated therewith, the pre-established model governing the processing of the formation data to determine electrical parameters regarding the earth formation, the method comprising:

(a) providing a simplified model associated with the measuring device, the simplified model making at least one simplifying assumption about the pre-established model;

(b) receiving a set of collected formation data regarding the earth formation, the set of collected formation data collected by the measuring device;

(c) normalizing the set of collected formation data to derive a renormalized dataset, wherein the renormalized dataset is substantially consistent with each of the simplifying assumptions in (a), said normalizing including transforming the set of collected formation data into the renormalized dataset according to weighted sums, the weighted sums comprising:

$$g'_a = \sum_{i=1}^{N} c_{ia} f_{ia}(g_a)$$
$$g'_p = \sum_{i=1}^{N} c_{ip} f_{ip}(g_p)$$

where g_a and g_p represent collected formation data, g'_a and g'_p represent corresponding members of the renormalized dataset, $i = 1$ to N terms in the weighted sums, f_{ia} and f_{ip} are functions representing preselected transformations between mandrel and point-dipole data over prescribed trajectories in the g_a, g_p plane, and c_{ia} and c_{ip} are coefficients chosen to produce values for g'_a and g'_p that approximate point-dipole values over an anticipated range of g_a and g_p.; and

(d) applying the renormalized dataset to the simplified model to estimate at least one electrical parameter of the earth formation.

43. The method of claim 42, in which the measurement device comprises a mandrel, and wherein at least one of the simplifying assumptions in (a) includes a simplified assumption with respect to the effect of the mandrel on the pre-established model.

44. The method of claim 42, in which the measurement device comprises a transmitter antenna of finite size, and wherein at least one of the simplifying assumptions in (a) includes an assumption regarding the size of an antenna in the simplified model.

45. The method of claim 44, wherein the assumption regarding the size of an antenna in the simplified model is that said antenna is infinitesimal.